ENVIRONMENTAL MANAGEMENT:

STREAM ANALYSIS WITH RELATION TO ACID MINE DRAINAGE

GRADES 9 to 12

DURATION: 5 DAYS 40 min Periods

Lesson Plan Created by:

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What is Acid Mine Drainage (AMD)?

A watershed is the line of division between two adjacent rivers or lakes with respect to the flow of water by natural channels into them and the natural boundary of a basin. The Clean Water Action Plan was established to monitor and remediate the quality of water in our nations watersheds. It establishes standards for a watersheds nutritional and dissolved metals content and if these are exceeded the waterway must undergo immediate remediation.

Dissolved metals suspended in solution such as ferric iron and ferrous iron, (the orange pollution you sometimes see) as well as aluminum, and manganese all contribute to water pollution. Aluminum ranks third in the Earth's abundant elements and is the most abundant metal in the Earth's crust. Dissolved aluminum remains suspended in water between the pHs or 3 and 4. Due to its strong affinity to oxygen, aluminum rarely occurs in its natural metal states near the surface. Instead it forms many alloys with zinc, copper, manganese, magnesium and other elements with similar chemical properties. This same property is responsible for the classification of aluminum as a contaminant and neurotoxin. When introduced to aquatic environments (i.e. rivers, streams, and wetlands) aluminum attaches onto plant roots and inhibits the intake of oxygen. Physical abnormalities in humans and animals associated with aluminum poisoning include memory loss, tremors, muscle twitching, and several types of dementia. These apparent threats to the environment and its inhabitants are why aluminum leaching and contamination should be controlled.

Acid mine drainage is water containing iron and sulfate and sometimes other metals, such as, manganese and aluminum. It is often acidic (low pH) and is commonly referred to as acid mine drainage or AMD. AMD forms through a series of chemical and biological reactions that occur when the pyrite (iron sulfide, a.k.a. fool's gold) found in coal and other rock strata is disturbed and exposed to oxygen and moisture as a result of mining operations. AMD may contaminate surface and ground water.

Why is it Important to Sample Streams?

To identify sources of mine drainage so that the quality of water can be improved. This is important to wildlife, aquatic (fish & frogs) and mammals (such as deer and small animals) so that they can flourish in their environment. Clean water is also important to people who use the rivers and streams for drinking water as well as for recreational uses. Water is an essential ingredient for boaters, swimmers, fisherman, and hunters.

OBJECTIVE

- The students will be able to work in cooperative learning groups to study the effects of acid mine drainage as it affects surface water streams and tributaries.
- The students will be able to explore the many different types of careers in environmental science.
- Collecting and analyzing data.
- Creating graphs to plot the data.
- Careers available geologist, hydrologist, engineering, environmental scientist, biologist as well as many other professions.
- Students will be able to perform laboratory testing using pH paper and/or meter

SKILLS AND KNOWLEDGE YOU NEED

- How to read and interpret a chart or graph.
- Use of the Scientific Method.
- How to read and interpret a topographic map.
- How to record data, analyze results and draw conclusions
- Knowledge of the pH scale.

MATERIALS NEEDED

pH Meter

pH Paper

Plastic Sample Bottles w/cap (recommended 125 ml)

pH meter calibrating buffer solutions

Map (Topographical)

Note Book with Pencil or Pen

Graph Paper

Marking Flags

Permanent Markers

MATERIALS NEEDED cont'd

Ice and Ice Chest (cooler)

Hydrochloric Acid

Strongly Recommended Optional Equipment:

Rubber Boots (waders)

Insect Repellent

PROCEDURE

Sampling must be completed in a one day field trip.

- Separate students into cooperative groups of 3 or 4 students.
- Research topographical map web sites to identify potential local streams to be sampled.
- Begin sampling procedure at the mouth of the stream.

Helpful hint: sampling must be done starting at the mouth so that you do not collect turbid water. Be careful not to stir up sediment when collecting your samples.

- Have students mark and flag the location where the sample is taken. (E.g. BR-1, for Beams Run stream location No.#1).
- Take the samples (mark sample bottle XX-1).
- Record sample location in logbook.

Helpful hint: Where tributaries flow into main stream, the sample should be taken approx. 10 feet up the tributary. The main stream should be sampled approx. 10 feet up stream infront of the tributaries entrance.

- After the stream has been sampled place all samples collected into an ice chest for transportation back to the classroom. Refrigerate immediately upon returning to classroom.
- Measure one set of samples for pH using pH paper or a pH meter if available, record results.
- Have students analyze their results by identifying any potential polluting tributaries of the stream. Have the students research the mining history of your area. Also students can research methods of active and passive treatment used today to remediate abandoned mines.

Laboratory Activity – Simulation of Abandoned Mine Remediation

Create your own Acid Mine Drainage, and neutralize it the way industry would when reclaiming a mining site.

- Prepare 2 separate solutions of Ferrous Sulfate (Fe SO_4) by dissolving into water into 2 large glass beakers
- Measure pH level. (Note: Ferrous Sulfate lowers the pH due to the chemical reaction with water creating sulfuric acid ($FeSO_4 + H_20 + O_2 \rightarrow H^+ + SO_4 + Fe^{2+}$)
- In one solution slowly add a 5 % NaOH, observe and record any change in color and pH.
- In the second Ferrous sulfate solution - add lye - you must prepare a lye slurry in a separate flask/beaker first, again adding slowly while observing and recording any change in color and pH.

(Note: A green color change should be observed immediately, if allowed to sit for several days the green sludge will change to an orange sludge – this is the iron coming out of solution. Relate this to students as the orange colored creeks they may have seen before which are most prevalent in old mining towns.)

Vocabulary Words

Alkalinity

pH Scale

Tributary

Wetland

Cattail Reeds

Limestone Bed

Graphing

Base Solution

Calibration

Spoils Pile

Coal

Strip Mining

Remediation

Geologist

Diversion Well

Ferrous Iron

Ferric Iron

Pyrite

Turbid

TEACHER RESOURCES

www.netl.doe.gov - National Energy Technology Laboratory – U S. Dept. of Energy

www.topozone.com – This site will provide the topographic map needed to locate a local stream.

www.usgs.gov - United States Geological Survey

www.coolscience.com

REFERENCES

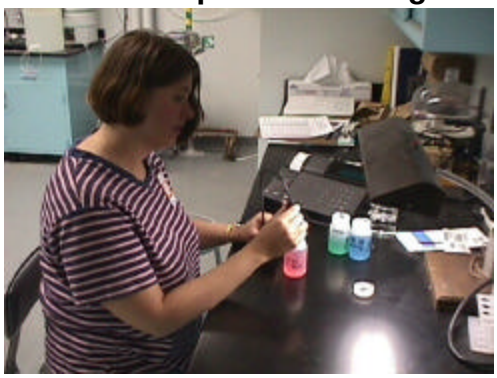
George R. Watzlaf – U.S. Dept. of Energy

Roderick D. Brown – HBSU student

RINSE BOTTLES BEFORE SAMPLING

COLLECTING WATER SAMPLES

CALIBRATE pH meter using buffer solutions 4.0, 7.0 and 10.0



CHECKING pH of WATER SAMPLES